Solution to Homework Set #4

ENCE 627 – Decision Analysis for Engineering - Fall 2003

Assigned T, 10/7 Due T, 10/14

Problem 1

Textbook (CR): 10.4

***** SOLUTION *****

One alternative is to estimate the fractiles by drawing lines on Figure 10.4:

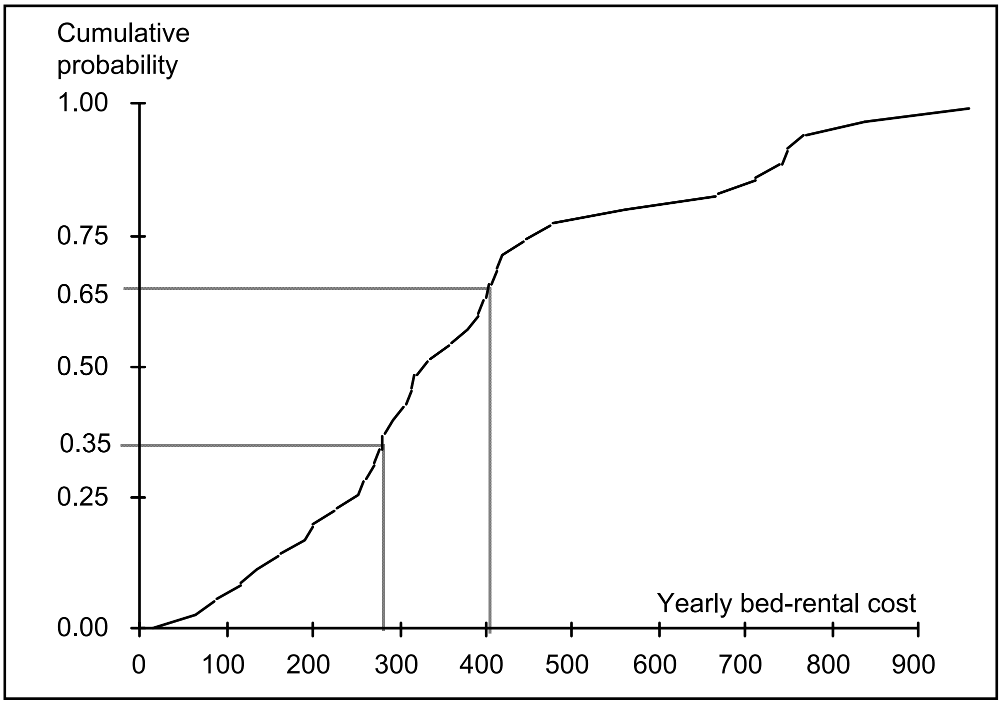


Figure 10.4. Estimated CDF for the halfway-house data.

From this, we estimate $x_{0.65} \approx \$400$ and $x_{0.35} \approx \$275$.

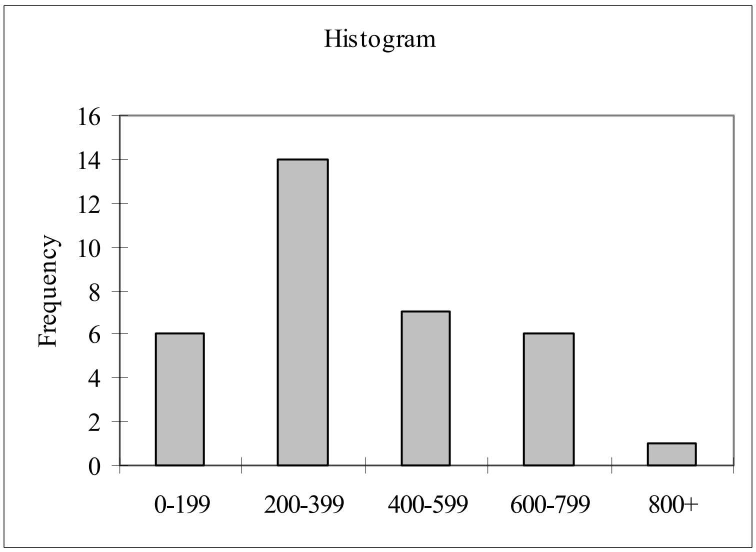
Or we can use BestFit to compute the desired fractiles. Open a new BestFit model by clicking on the BestFit icon on the DecisionTools toolbar. The halfway house data is provided in the "Data.xls" worksheet for the textbook. Copy and paste the halfway house data as the sample data. Insert a New Distribution window, and select Input Data as the Source, Fit1 as the Tab, and select the input sheet as the source of the input values. The halfway house data is then graphed in the Distribution window. Set the Left P value to 35%, and the corresponding Left X is $281.8. Set the Right P value to 65% and the corresponding Right X is $402.6.

Problem 2

Textbook (CR): 10.5

***** SOLUTION *****

Answers to this question will vary depending on the intervals chosen. A histogram with four intervals of width 200, plus a "catch-all" interval for larger values is shown below. It was created using the Data Analysis- histogram tool and the provided halfway house data. The axes labels were cleaned up to reflect the range of the bins after the chart was created.



Note that the last category has only one observation. This is not strictly appropriate, but it does not compromise the representation of the data.

Problem 3

Textbook (CR): 10.9

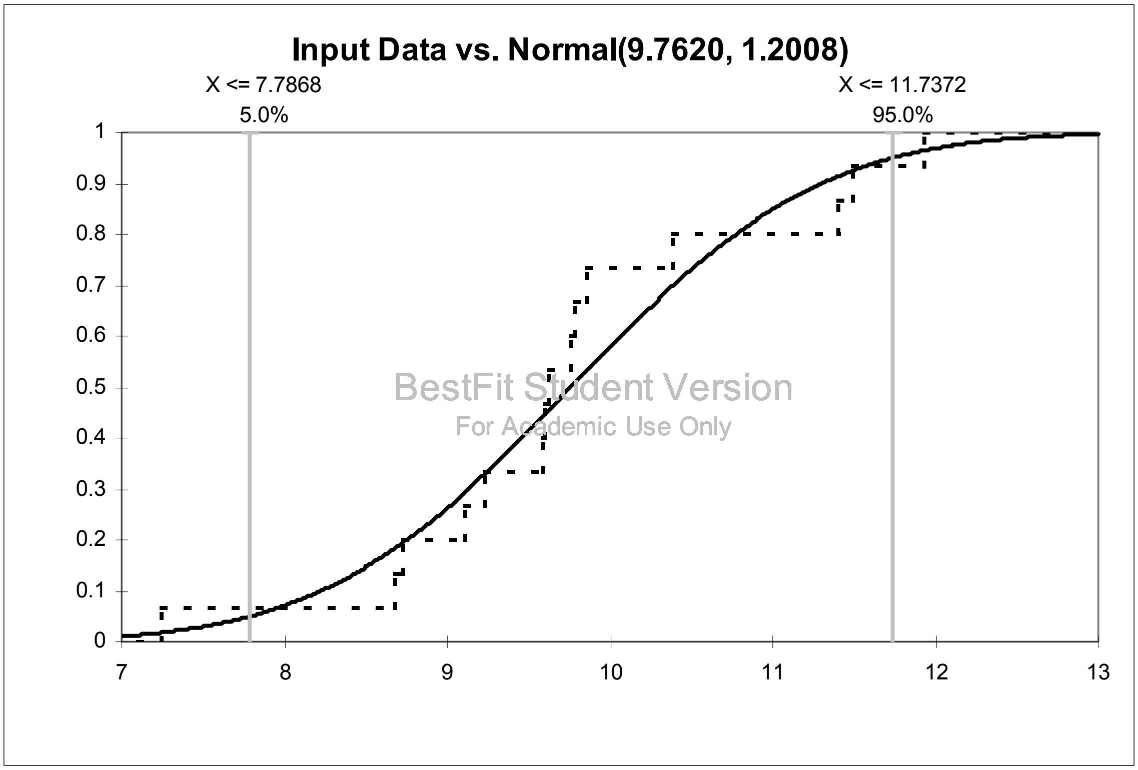
***** SOLUTION *****

a. We can use the middle value between each data point to create a smooth CDF as described in the text on page 401.

Obs #	Weight	x_i	P(Weight < x_i)
1	7.24	7.96	0.07
2	8.68	8.71	0.13
3	8.73	8.92	0.20
4	9.11	9.17	0.27
5	9.23	9.41	0.33
6	9.59	9.60	0.40
7	9.60	9.61	0.47
8	9.62	9.69	0.53
9	9.76	9.78	0.60
10	9.79	9.83	0.67
11	9.86	10.13	0.73
12	10.39	10.90	0.80

13	11.41	11.45	0.87
14	11.49	11.71	0.93
15	11.93		

Thus, we have approximately P(Weight < 9.5 grams) = 0.35. Or we can use BestFit to fit the data. Using the input data, and setting the Left X value to 9.5, the desired probability is 33.33%.



b. Sample mean = 9.76 grams, sample standard deviation = 1.20 grams.

$P_N(X < 9.5 \mid \mu = 9.76, \sigma = 1.20) = P(Z < -0.22) = 0.41$.

c. The normal distribution probability is not terribly close. However, it is not terribly far off. The only serious departure from normality is that the distribution is slightly skewed. BestFit recommends other distributions as better fits including Inverse Gaussian, Logistic, Log Logistic, and the Lognormal.

Problem 4

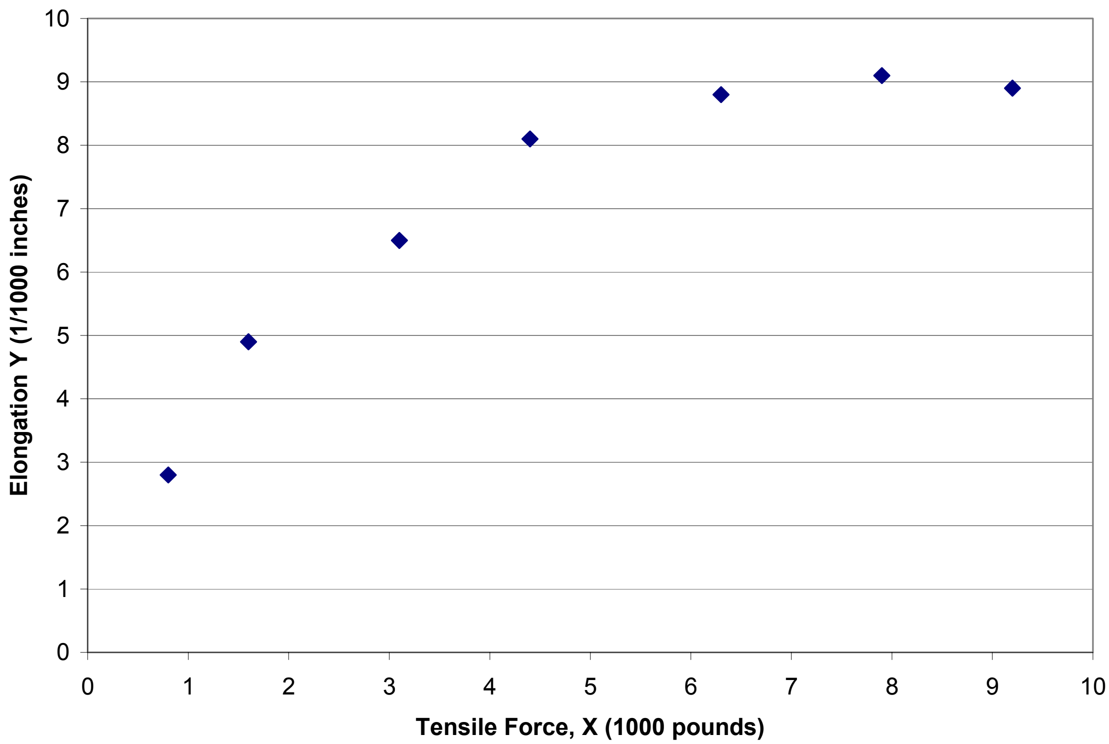
The data shown are the results of a tensile test of a steel specimen, where *Y* is elongation in thousandths of an inch that resulted when the tensile force was *X* thousands of pounds.

X	0.8	1.6	3.1	4.4	6.3	7.9	9.2
Y	2.8	4.9	6.5	8.1	8.8	9.1	8.9

(a) Plot the data as Y (dependent) versus X (independent), and make a general assessment of the quality of the data for prediction.
(b) Using the data, find a bivariate linear model that can be used to estimate the elongation Y of steel specimen.
(c) Compute the coefficient of variation R, and discuss what it says about the association between the two random variables Y and X.
(d) Superimpose the graph resulting from the linear model on the plot of Part (a).
(e) Estimate the elongation when the force is 5,000 pounds.

***** SOLUTION *****

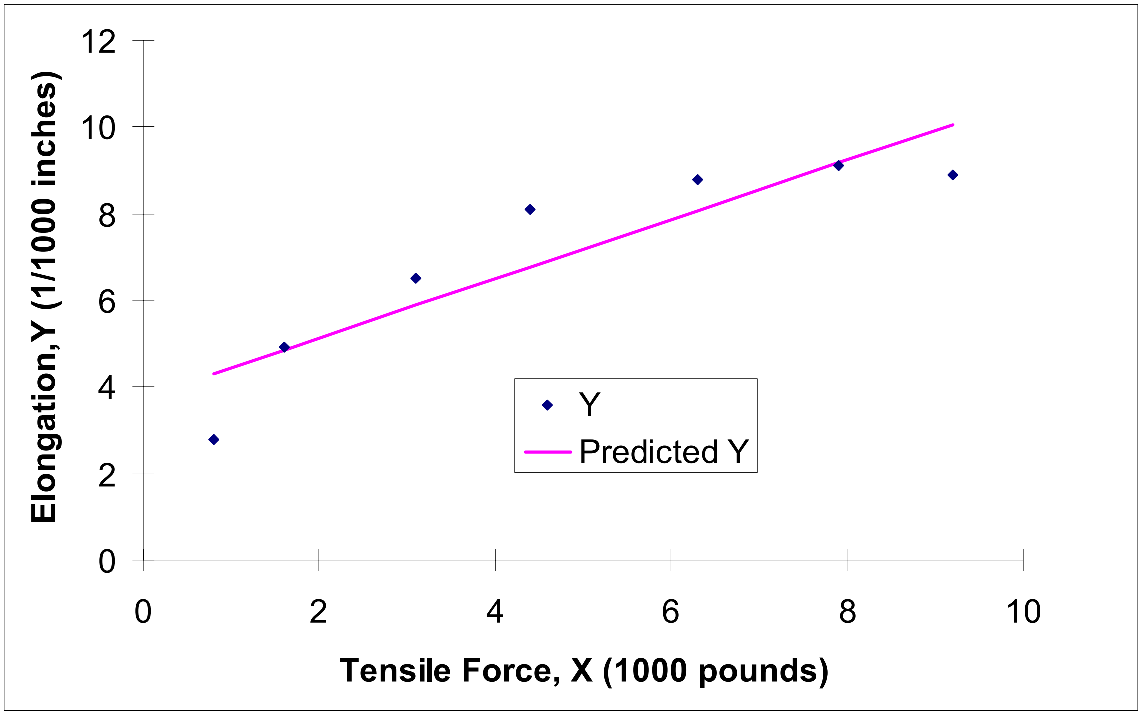
(a) Plot:



(b) $\hat{Y} = 3.75063049 + 0.686053651X$

(c) $R = 0.904965637$, strong positive association between Y and X.

(d) Superimposing the graphs:



(e)

$$\hat{Y}(5) = 3.751 + 0.686X$$
$$= 3.751 + 0.686(5) = 7.181 \text{ (1/1000 inches)}$$

Problem 5

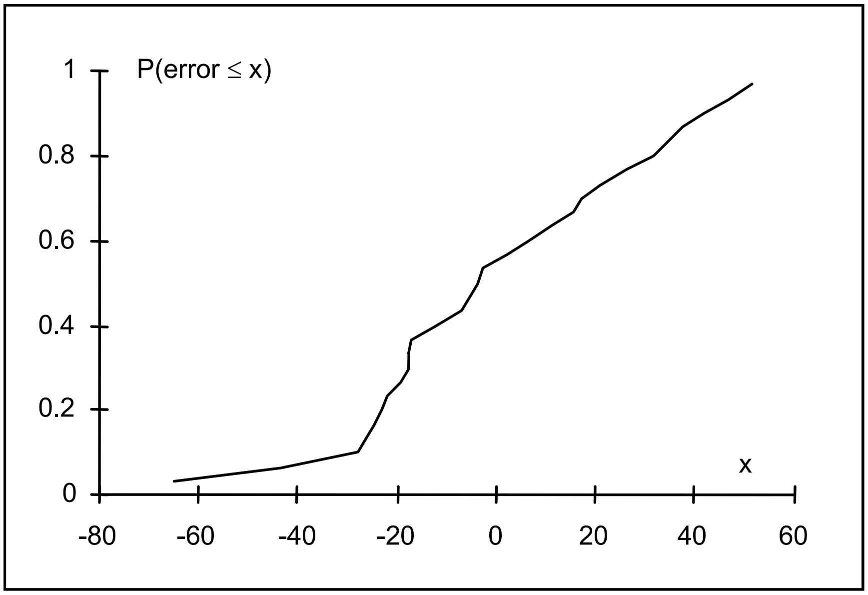
Textbook (CR): 10.13

*** SOLUTION ***

a. The regression equation is:

E(Sales Price | House Size, Lot Size, Attractiveness)
= 15.04 + 0.0854 (House Size) + 20.82 (Lot Size) + 2.83 (Attractiveness).

b. Creating this graph requires calculation of the residuals from the regression (which can be done automatically with Excel's regression procedure). Then use the residuals in exactly the same way that we used the halfway-house data in Table 10.2 in the text to create a CDF.



c. The expected Sales Prices for the two properties are

1. E(Sales Price | House Size = 2700, Lot Size = 1.6, Attractiveness = 75)

   = 15.04 + 0.0854 (2700) + 20.82 (1.6) + 2.83 (75)

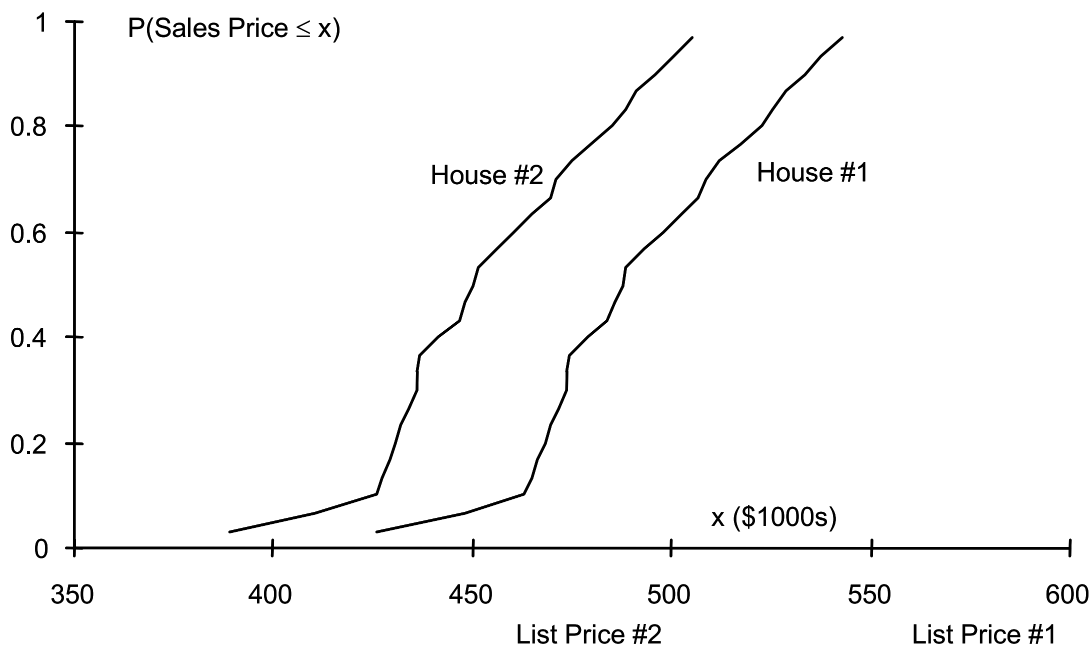
   = 491 ($1000s).

2. E(Sales Price | House Size = 2000, Lot Size = 2.0, Attractiveness = 80)

   = 15.04 + 0.0854 (2000) + 20.82 (2.0) + 2.83 (80)

   = 453.7 ($1000s).

d.



From the graph, it is easy to see that House #2 is reasonably priced, according to the model. At $480K, its list price falls just below the 0.80 fractile of the distribution. Presuming that the owners have built in some negotiating room, it looks as though Sandy may be able to make a reasonable offer and obtain the property for a price close to the price suggested by the model.

House #1 is a different story. Its list price falls well above the probability distribution given by the model. It is either way overpriced (which suggests that Sandy may have to offer a very low price), or there is something about the house that increases its value but is not reflected in the model.

Problem 6

Textbook (CR): 2.1 (only a and b)

***** SOLUTION *****

a. Some objectives might be to minimize cost, maximize safety, maximize comfort, maximize reliability, maximize cargo capacity (for shopping), maximize maneuverability (in city traffic). Students will undoubtedly come up with others as well.

b. In this new context, appropriate objectives might be minimize travel time, maximize exercise, minimize total transportation cost, minimize use of fossil fuels, maximize ease (suitably defined) of visiting friends and shopping. New alternatives to consider include using a bicycle or public transportation, walking, rollerblading, skateboarding, motor scooter, renting a car only when necessary. One might even consider moving in order to live in a more convenient location.

Problem 7

Textbook (CR): 2.9

***** SOLUTION *****

$$\text{NPV} = \frac{-2500}{1.13^0} + \frac{1500}{1.13^1} + \frac{1700}{1.13^2}$$

$$= -2500 + 1327.43 + 1331.35$$

$$= \$158.78.$$

Or use Excel's function NPV:
=-2500+NPV(0.13,1500,1700) = $158.78